Space Weather Technical Forecast

Issued on Thursday 26 December 2024 at 12:27 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: Occasional R1/R2 radio blackouts expected throughout.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Moderate, with two M-class flares observed. The peak flare measured M7.3 at 26/0315 UTC from AR3938 with some contribution from AR3933. There are currently twelve sunspot regions on the disc. The largest region on the disc remains AR3936 approaching north centre disc, but this still appears to have a straightforward magnetic structure. AR3938 in the northeast has been the most active region of late, and is showing some minor magnetic complexity. AR3928 and AR3933 in the southwest both faded a little, with AR3928 also showing a reduction in magnetic complexity. AR3932 at south centre disc has seen most of its leading spots fade, with the one remaining spot only just retaining a rudimentary penumbra. Remaining groups appear small and simple at this time.

There have been several large far sided CMEs in the last 24 hours, making near sided CME analysis more difficult. A CME visible moving northeast in coronagraph imagery from 25/1730UTC onwards is considered likely to miss Earth.

Solar Wind / Geomagnetic Activity: Solar winds, as observed at L1 by ACE, showed a return to background conditions after connection to CH01/-. The wind speed fell from slightly elevated levels around 480km/s to background levels around 370km/s. The density was initially below average, with a slow rise towards average levels. The Interplanetary Magnetic Field was weak throughout below 5nT. The north-south component, Bz, varied weakly between +/-3nT. The phi angle was negative (towards the Sun) throughout. Geomagnetic activity was Quiet (Kp 0-1).

Energetic Particles / Solar Radiation: High energy proton flux (greater than 10MeV) at GOES 18 showed a continuing gradual decline, well below the S1/Minor Radiation Storm threshold.

High energy electron flux (greater than 2MeV) at GOES16 was at moderate levels, peaking at 25/1505UTC near 770pfu. The associated 24-hour fluence was below the Active (1e8 integrated flux) threshold on a flat trend. The 26/0001UTC observation was 2.92e7 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Further M-class flares are expected, with a slight chance of isolated X-class flares throughout.

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Solar Wind / Geomagnetic Activity: The CME from 23 Dec is now considered likely to have missed Earth. Whilst no further CMEs are currently expected, there have been numerous CMEs in recent days and confidence in this aspect of the forecast is lower than usual. Solar winds have now declined to background levels after the recent connection to CH01/-. A further enhancement is possible, but unlikely on Days 1 and 2 (26 and 27 December). Overall it is considered most likely that wind speeds will remain at background or perhaps slightly elevated levels in the absence of CME enhancement.

Geomagnetic activity is expected to be mainly Quiet to Unsettled, but with a very slight risk of Active to G1/Minor Storm intervals should any glancing CME effects occur.

Energetic Particles / Solar Radiation: There is a slight chance of S1/Minor Radiation Storm or greater enhancements during the period. In the absence of any further notable flares, ongoing slightly enhanced proton counts should ease towards background levels in the coming days.

There is a slight chance of exceeding Active levels through this period, now that the forecast CME is thought to have missed Earth.

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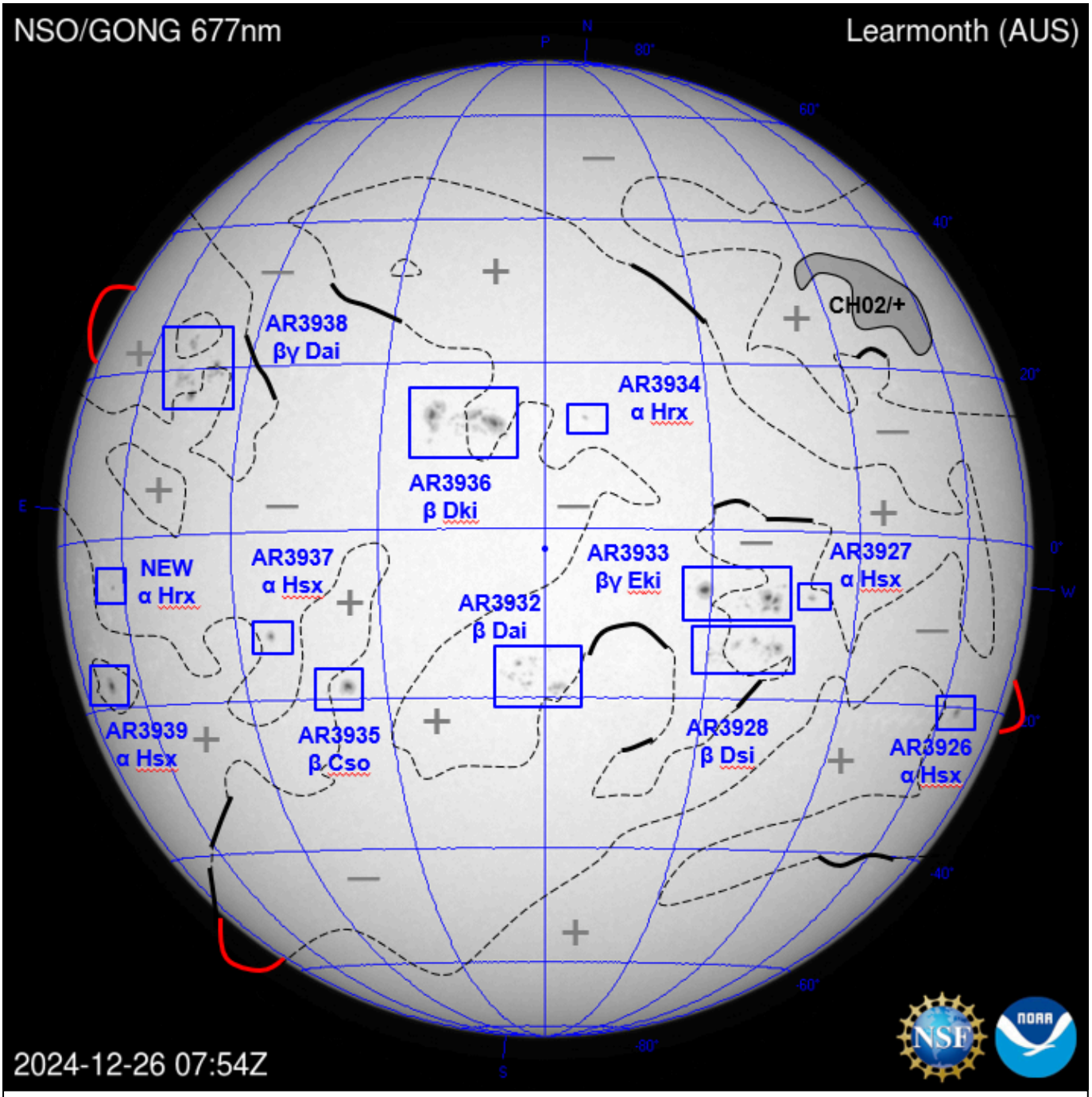
Figure 1: Solar synoptic map valid at 26/0800 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms

The CME generated by the M8.9 flare from AR3923 and a nearby, sympathetic filament lift-off on 23 Dec is now considered likely to have missed Earth. Whilst no other Earth directed CMEs are mentioned in this forecast, there have been numerous CMEs in recent days, some of which have been hard to analyse. As such confidence in this aspect of the forecast is lower than usual.

Solar winds have now declined to background levels after the recent connection to CH01/-. A further enhancement is possible, but unlikely on Days 1 and 2 (26 and 27 December) from CH02/+ located in the northwest disc. Enlil is showing a HSS from an uncertain source at the start of this period, but this is viewed as very low confidence especially given the now background wind speeds. The source of this could be a coronal hole obscured by magnetic looping to the north of AR3933, but overall it is considered more likely that wind speeds will remain at background or perhaps slightly elevated levels in the absence of CME enhancement.

Geomagnetic activity is expected to be mainly Quiet to Unsettled, but with a very slight risk of Active to G1/Minor Storm intervals should any glancing CME effects occur.

Geomagnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	5	5	5	5
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

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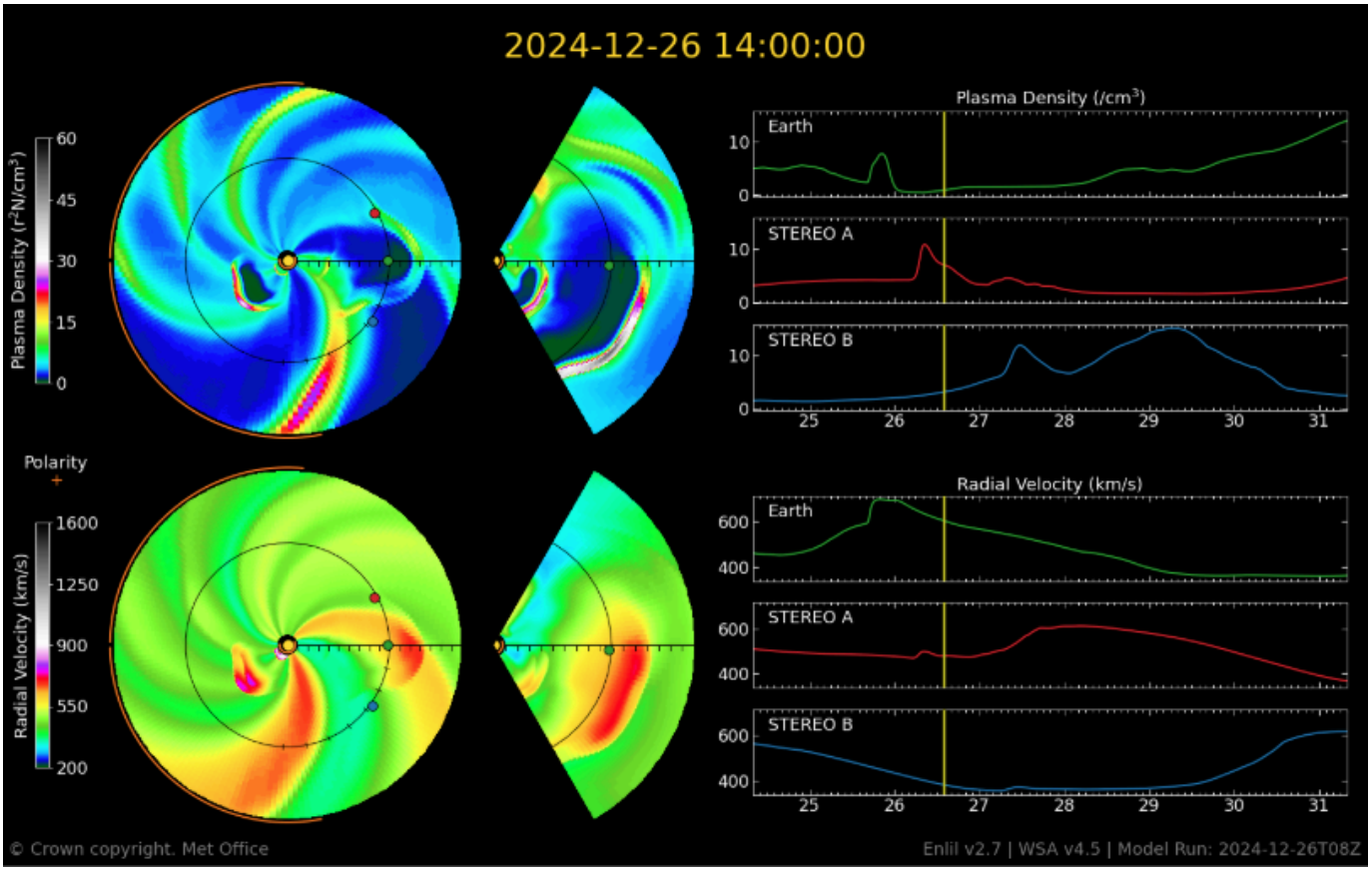
Figure 2: MOSWOC Enlil forecast. The CME anticipated yesterday evening is now thought to have missed Earth, but we cannot completely rule out glancing blows in the coming days. The HSS shown today into tomorrow is thought unlikely to occur.



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Radio Blackouts - X-Ray Flares

The Penticton 10.7cm flux has been on a strong rising trend, reaching a peak for this rotation and just short of the peak last seen at Hallowe'en. The Penticton flux can be an indicator of the risk of larger flares, but that said none of the visible sunspot regions currently show significant magnetic complexity. There are twelve sunspot regions on the disc. at present. The largest region on the disc remains AR3936 approaching north centre disc, but this still appears to have a straightforward magnetic structure. AR3938 in the northeast has been the most active region of late, and is showing some minor magnetic complexity. AR3928 and AR3933 in the southwest both faded a little, with AR3928 also showing a reduction in magnetic complexity. AR3932 at south centre disc has seen most of its leading spots fade, with the one remaining spot only just retaining a rudimentary penumbra. Remaining groups appear small and simple at this time.

Recurrence suggests the potential for further sunspot regions to round the eastern limb later in the period, with this supported by recent far-side CME activity although far-side sounding output is not showing any significant regions. None of the larger sunspot regions leave the disc in the four day forecast period.

The assessment of any new regions notwithstanding, flare risk looks to remain elevated during the period and further M-class flares are expected, with a slight chance of X-class flares maintained throughout, pending further developments.

X-Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 (M Class)	Yes	80	80	80	80
Very Active	R3-R5 (X Class)	No	15	15	15	15

Figure 3: X-ray flux at GOES16 and 18, showing two M-class flares in the past 24 hours.

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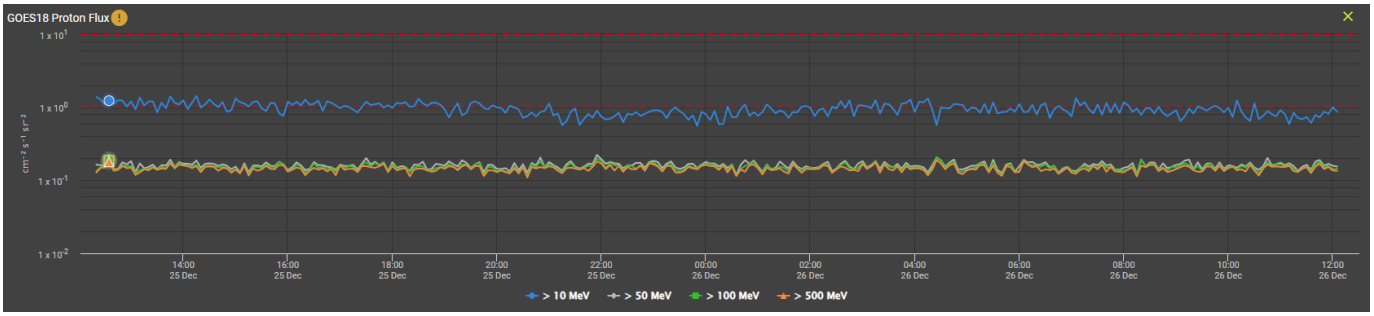
Solar Radiation Storms (High Energy Protons)

High energy proton counts are slowly declining and should continue to ease towards typical background values in the coming days in the absence of significant flaring. There remains a slight chance of S1/Minor Solar Radiation storms or greater, should any significant flares occur from the larger regions on the disc as they move into more favourable western locations for connection with Earth. That said, none of these regions currently show any significant magnetic complexity, which reduces the risk of them producing proton enhancement.

Radiation Storms Probability (Exceedance)	Level ($cm^{-2}sr^{-1}s^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	10	10	15	15
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and/or 50 MeV ≥ 10pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

Figure 4: Proton flux at GOES18, with 10MeV protons still a little above normal background.



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High Energy Electrons (≥ 2MeV)

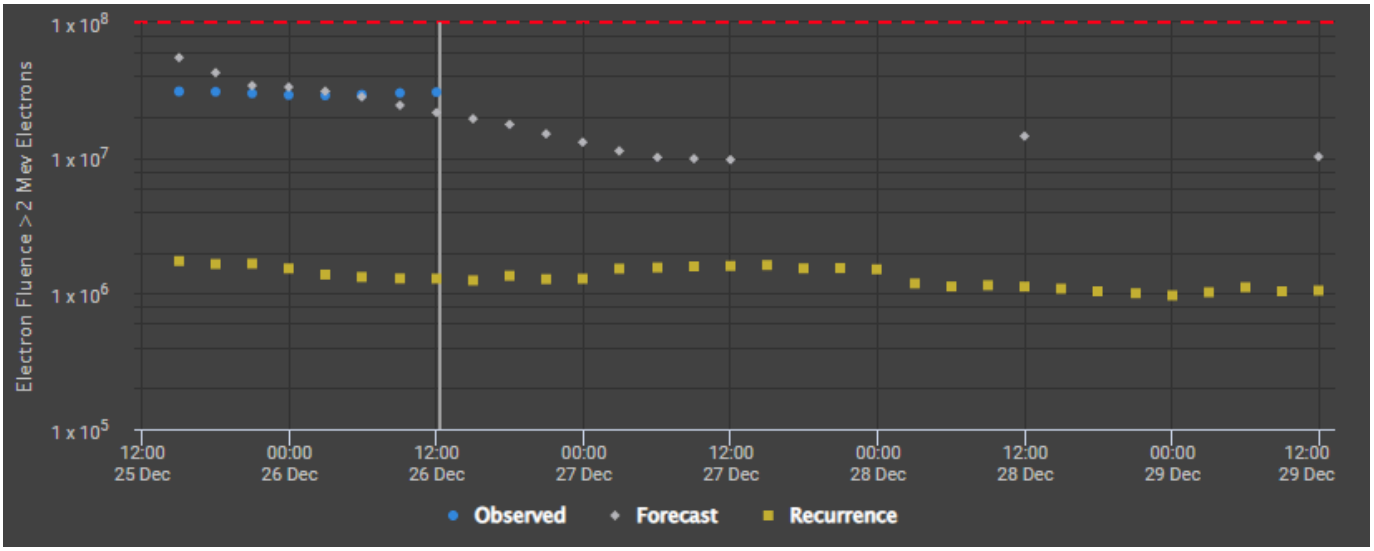
Current high energy electron flux has been at moderate levels in the last 24 hours. Now that the solar wind pressure from CH01/- has eased, diurnally high electron flux levels are possible during this period. The anticipated CME from 23 Dec is now considered likely to have missed Earth, so electron flux may show a slight rise in the short term, followed by a very gradual decline over the following days.

Electron fluence has been steady over the last 24 hours, and is most likely to remain below the Active threshold. However, there is a slight chance of exceeding Active levels through this period.

MOSWOC REFM is now showing a steady forecast through the next three days, which is not unreasonable. Given the likely lack of CME influence in the coming days, its forecast can be followed with greater confidence.

GEO Electron Environment	Level ($cm^{-2}sr^{-1}$ day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ 1×10^{8}	No	20	20	20	15
Very Active	≥ 2 MeV ≥ 1×10^{9}	No	1	1	1	1

Figure 5: MOSWOC REFM showing a steady trend below Active in the next three days.



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